

What is claimed is:

1. A system for detecting the level of liquid in a vessel, comprising:
 - a detector assembly including
 - a thermally conductive substrate,
 - 5 an heater mounted on said substrate such that said heater is thermally coupled to the interior of the vessel, said heater being able to be actuated to add heat to the surface of the substrate thermally coupled to the interior of the vessel, and
 - 10 a sensor mounted on said substrate in proximity to said heater such that discrete elevations of the interior of the vessel are thermally coupled to corresponding longitudinal portions of said sensor to generate an electrical signal defining a temperature signal, said correspondence being incrementally continuous such that the elevations corresponding to said portions of said sensor increase from one to the other of the ends of said sensor, said sensor being able to be actuated to detect the temperature in the vessel in proximity to the sensor indicative of the temperature detected by said sensor, said sensor having a vertical dimension sufficiently large such that said temperature signal will vary in proportion to said longitudinal portion of said sensor thermally coupled to the liquid;
 - 20 a processor electrically connected to said sensor for receiving said temperature signal after actuation of said heater, said processor being programmed to use said temperature signal to calculate the elevation of the
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upper surface of the liquid in the vessel thereby to
30 generate an electrical signal defining an elevation
signal indicative of the elevation of the liquid upper
surface relative to the lower end of said sensor;

an interface electrically connected to said
processor for receiving said elevation signal for use as
35 the basis for communicating to the user the elevation of
the liquid upper surface; and

a power supply electrically connected to said
heater, sensor, processor, and interface.

2. A system as set forth in claim 1, wherein said
longitudinal portions of said sensor define a
longitudinal axis of said sensor having a vertical
orientation.

3. A system as set forth in claim 1, wherein said
lower end of said sensor is positioned above the lower
inner surface of the vessel by a vertical clearance,
said processor being programmed further to interpret
5 the elevation signal to be indicative of the elevation of
the liquid upper surface relative to the lower end of
said sensor and of said vertical clearance such that said
interface communicates to the user the elevation of the
liquid upper surface relative to the lower inner surface
10 of the vessel.

4. A system as set forth in claim 1, wherein said
sensor comprises a potentiometer wherein the resistance
to electrical conductivity of said sensor varies in
proportion to the temperature detected by it, said
5 temperature signal being equal to said resistance,

10 said programming of said processor comprising using
said temperature signal to measure said resistance of
said sensor, said programming further comprising using
said resistance to calculate the elevation of the liquid
upper surface.

5. A system as set forth in claim 4, wherein said
sensor is defined by an intermediate sensor, said system
further comprising:

10 an upper sensor mounted on said substrate adjacent
to the upper end of said intermediate sensor; and
a lower sensor adjacent to the lower end of said
intermediate sensor,

15 said upper and lower sensors being thermally coupled
to the interior of the vessel to detect the respective
temperatures therein in proximity to said upper and lower
sensors,

15 said upper and lower sensors being able to be
actuated to produce respective electrical signals
defining temperature signals indicative of the respective
temperatures detected by them, said upper and lower
sensors each comprising a potentiometer wherein the
resistance to electrical conductivity of each of said
upper and lower sensors varies in proportion to the

respective temperatures detected by them, said
20 temperature signals of said upper and lower sensors being
equal to said respective resistance values thereof,
said processor being further programmed to calculate
the distance between said lower sensor and the liquid
upper surface according to the following equation:

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$$l = \frac{R_i - R_{vp}}{R_{1q} - R_{vp}}$$

30 where l = longitudinal fraction of said intermediate
sensor below said liquid upper surface;

R_i = resistance of said intermediate sensor;
35 R_{vp} = resistance of said upper sensor when exposed to
vapor only; and
 R_{1q} = resistance of said lower sensor when exposed to
liquid only,
40 said processor being further programmed to calculate
the vertical component of "l" for use as the basis for
said generation of said elevation signal.

6. A system as set forth in claim 5, wherein said
intermediate sensor has a longitudinal axis, said
intermediate sensor being oriented such that said
longitudinal axis is vertical,
5 said processor being further programmed such that
said vertical component equals "l".

7. A system as set forth in claim 4, wherein said sensor is defined by an intermediate sensor, said system further comprising:

5 an upper sensor mounted on said substrate adjacent to the upper end of said intermediate sensor; and
a lower sensor adjacent to the lower end of said intermediate sensor,

10 said upper and lower sensors being thermally coupled to the interior of the vessel to detect the respective temperatures therein in proximity to said upper and lower sensors,

15 said upper and lower sensors being able to be actuated to produce respective electrical signals defining temperature signals indicative of the respective temperatures detected by them, said upper and lower sensors each comprising a potentiometer wherein the resistance to electrical conductivity of each of said upper and lower sensors varies in proportion to the respective temperatures detected by them, said
20 temperature signals of said upper and lower sensors being equal to said respective resistance values thereof,

said processor being further programmed to calculate the distance between said lower sensor and the liquid upper surface according to the following equation:

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$$l = \frac{R_1 - R_{vp}}{R_{1q} - R_{vp}}$$

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where l = number of increments between a lower end of said intermediate sensor and the liquid upper surface;

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L = total number of increments between an upper end and said lower end of said intermediate sensor (any number of increments are possible, higher number increases resolution of calculation and the actual count is arbitrary and determined only by resolution requirements);

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R_i = resistance of said intermediate sensor;

45

R_{vp} = resistance of said upper sensor without scaling;

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$R_{vp'}$ = resistance of said upper sensor at the observed temperature when exposed to vapor only, scaled by dividing by the total number of increments; and

55

$R_{lg'}$ = resistance of said lower sensor at the observed temperature when exposed to liquid only, scaled by dividing by the total number of increments;

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said processor being further programmed to calculate the vertical component of "l" for use as the basis for said generation of said elevation signal.

8. A system as set forth in claim 7, wherein said intermediate sensor has a longitudinal axis, said intermediate sensor being oriented such that said longitudinal axis is vertical,

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said processor being further programmed such that said vertical component equals "l".

9. A system as set forth in claim 4, wherein said heater is constituted by said sensor.

10. A system as set forth in claim 1, wherein said sensor is disposed in the interior of the vessel.

11. A system for detecting the level of liquid in a vessel, comprising:

a detector assembly including

a thermally conductive substrate,

5 a heater mounted on said substrate such that said heater is thermally coupled to the interior of the vessel, said heater being able to be actuated to add heat to the surface of the substrate thermally coupled to the interior of the vessel, and

10 upper, intermediate and lower sensors mounted on said substrate in proximity to said heater, said upper sensor being at a higher elevation relative to said lower sensor, said intermediate sensor being at an elevation between said upper and lower sensors, said upper and

15 lower sensors being thermally coupled to the interior of the vessel to detect the temperature therein in proximity to said upper and lower sensors, said upper and lower sensors being able to be actuated to generate respective electrical signals each defining a temperature signal

20 indicative of said temperatures detected by said upper and lower sensors, said intermediate sensor being mounted on said substrate such that discrete elevations of the interior of the vessel are thermally coupled to

corresponding longitudinal portions of said intermediate
25 sensor to detect the temperature in the vessel in
proximity to the sensor, said correspondence being
incrementally continuous such that the elevations
corresponding to said portions of said intermediate
sensor increase from one to the other of the ends of said
30 intermediate sensor, said intermediate sensor being able
to be actuated to generate an electrical signal defining
a temperature signal indicative of the temperature
detected by said intermediate sensor, said intermediate
sensor having a vertical dimension sufficiently large
35 such that said temperature signal will vary in proportion
to said longitudinal portion of said intermediate sensor
thermally coupled to the liquid;

40 a processor electrically connected to each of said
sensors for receiving said temperature signals after
actuation of said heater, said processor being programmed
to use said temperature signals to calculate the
elevation of the upper surface of the liquid in the
vessel thereby to generate an electrical signal defining
45 an elevation signal indicative of the elevation of the
liquid upper surface;

45 an interface electrically connected to said
processor for receiving said elevation signal for use as
the basis for communicating to the user the elevation of
the liquid upper surface; and

50 a power supply electrically connected to said
heater, intermediate sensor, lower sensor, upper sensor,
processor, and interface.

12. A system as set forth in claim 11, wherein said processor comprises an electronic microprocessor.